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# INVESTIGATION OF DYNAMIC BEHAVIOUR OF SOIL DAMS TAKING INTO ACCOUNT INELASTIC PROPERTIES OF SOILS

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One of the actual problems in the science of mechanics is the estimation of the stress-strain state and dynamic behaviour of various structures with complex geometry and heterogeneous structural features. This, in turn, requires the development and use of mathematical models and computational methods to estimate the dynamic state and strength parameters of structures, taking into account their structural features and real material properties.

The solution to the above problem, considering the previously mentioned factors, can be obtained most completely and accurately by using numerical methods: for example, the finite element method (FEM) or the finite difference method (FDM) [1, 2, 12, 13].

The static stress state and dynamic behaviour of various ground structures are considered in [3-9], which take into account the structural features of the structures, the inelastic properties of the soil, the interaction of the structures with the water environment of the reservoir and other features of the structures.

Research of the stress-strain state and dynamic behaviour of soil structures in considering their design features and actual operation have been studied insufficiently up to now, therefore, studies in this direction are of great scientific interest. Predicting the behaviour of ground structures should be based on the fullest possible consideration of all factors affecting their stress-strain state and dynamic behaviour under various types of loads.

On the basis of the above stated, this paper investigates the dynamic behaviour and stress-strain state of two soil dams with central cores under real

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dynamic (seismic) impacts taking into account soil moisture. Actual records of registered accelerograms of a number of earthquakes of different intensity, frequency spectrum and duration of impact are used as an external impact. The results obtained at different degrees of water saturation of the dam core soil are compared.

The earth dam under consideration has a trapezoidal cross-section, the crest and slopes of which are stress free, and kinematic boundary conditions are set at the base $\left(\bar{x} \in \sum_u\right)$.

The variational Lagrange equation based on the D'alembert principle given in [2] is used to formulate the dynamic problem:

$$\delta A = -\int_V \sigma_{ij}\delta\varepsilon_{ij}dV - \int_V \rho_i \ddot{\bar{u}}\,\delta\bar{u}\,dV = 0\,, \qquad (1)$$

Kinematic boundary conditions

$$\bar{x} \in \Sigma_u:\ \bar{u}_0(\bar{x},t) = \bar{\psi}_1(\bar{x},t)\,, \qquad (2)$$

initial conditions at $t=0$:

$$\bar{x} \in V:\ \bar{u}(\bar{x},0) = \bar{\psi}_2(\bar{x});\ \dot{\bar{u}}(\bar{x},0) = \bar{\psi}_3(\bar{x})\ . \qquad (3)$$

Here, $\bar{x} = \{x_1, x_2\}$, $\bar{u} = \{u_1, u_2\}$ - displacement vector; $\varepsilon_{ij}$, $\sigma_{ij}$ - components of the Cauchy strain tensor and stress tensor; $\delta\bar{u}$, $\delta\varepsilon_{ij}$ - isochronous variations of the displacement and strain vector; $\rho_i$ - material density of the elements of the considered structure; $\bar{\psi}_1$, $\bar{\psi}_2$, $\bar{\psi}_3$ - specified functions.

The physical properties of the soils of the prism (n=1,3) and core (n=2) of the dam are described by relations between stresses $\sigma_{ij}$ and strains $\varepsilon_{ij}$ of the form

$$\sigma_{ij} = \tilde{\lambda}_n \varepsilon_{kk}\delta_{ij} + 2\tilde{\mu}_n \varepsilon_{ij} \qquad (4)$$

The values of $\tilde{\lambda}_n$ and $\tilde{\mu}_n$ are Lame constants. When the moisture content of the soil in the dam core is taken into account, the values of $\tilde{\lambda}_n$ and $\tilde{\mu}_n$ are determined according to the model for subsidence soils proposed in [10]. $n$-corresponds to the part of the dam to which the mechanical characteristics refer, $\delta_{ij}$ is the Kronecker symbol.

Following the work [10], the functional dependences of physical and mechanical characteristics of soil on moisture content are determined by the formulas:

$$K(I_W) = K_{sat}\exp(\alpha(1 - I_W)); \qquad (5)$$

$$\nu(I_W) = \nu_0 + \varphi\ln(1 + I_W); \qquad (6)$$

here: $K_{sat}$ is the modulus of volumetric compression of water-saturated soil; $\nu_0$ is the Poisson's ratio of dry soil; $\alpha$ and $\varphi$ are empirical dimensionless coefficients characterising the degree of change in the corresponding mechanical characteristics of the subsidence soil. These mechanical characteristics of the soil are considered to be functions of the degree of water saturation of the soil $I_W = W / W_{sat}$, rather than of the moisture content $W$ itself.

The problem is to determine the displacement function $\bar{u}(\bar{x},t)$, strain tensors $\varepsilon_{ij}(\bar{x},t)$ and stress tensors $\sigma_{ij}(\bar{x},t)$ satisfying equations (1), (4) and conditions (2), (3) at any possible displacement $\delta\bar{u}$.

The variational problem (1) after finite element discretisation reduces to a Cauchy problem for a nonlinear system of high-order differential equations of the form [2]

$$[M]\{u\} + [C]\{u\} + [K]\{u\} = \{F(t)\} \qquad (7)$$

with initial conditions

$$\{u(0)\} = \{u_0\}; \{u(O)\} = \{u_O\} \qquad (8)$$

here $[K]$, $[M]$-matrices of stiffness and mass of the structure under consideration; $[C]$ is a matrix of dissipative forces (if they are taken into account); $\{u\}$ is the desired vector of movements, $\{F(t)\}$ – vector of external exposure.

Calculations were made for Tupolanga dam (180m high) with rock mass retaining prisms under the influence of three earthquake accelerograms: high-frequency accelerogram of Gazli [11], intensity 9 MSK, main period 0.1 seconds and duration of impact 8.74 seconds, accelerogram 7-12G66 - intensity 7 MSK, main period 0.9 seconds, duration of impact 23 seconds and accelerogram 7-25G40 - intensity 7 MSK, main period 0.37 seconds, duration of impact 12 seconds. The dam has a thin core of subsidence soil (loam) with parameters E = $2.399 \cdot 10^5$ t/m$^2$, $\gamma$= 2.0 t/m$^3$ , $\nu$=0.35, $\alpha$=2.5 $\varphi$=0.3.

Variation of intensity $\sigma_i(\bar{x},t)$ and stress components $\sigma_x(\bar{x},t)$, $\sigma_y(\bar{x},t)$ and $\tau_{xy}(\bar{x},t)$ were investigated at different soil moisture varying in the range of W=10-30%. Isolines of equal levels of intensity $\sigma_{i\,max}$ and tangential $\tau_{xymax}$ stresses in the dam profile were also plotted.

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The figure shows isolines of maximum values of stress intensity $\sigma_{i\,\max}$ in the profile of the Tupolanga dam taking into account soil moisture (Ω=20%) under real seismic action.

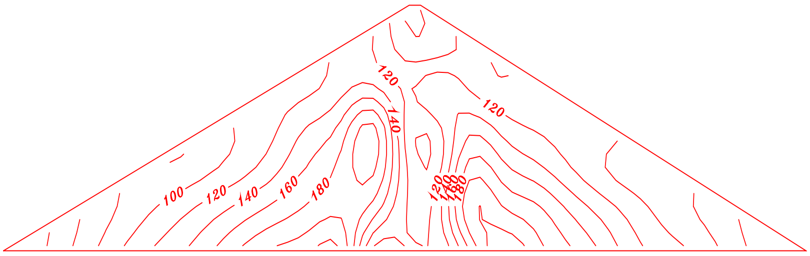


**Fig**. Lines of equal level of stress intensity $\sigma_{i\,\max}$ in the dam.

The analysis of the obtained results shows that the stress-strain state of the dam is significantly influenced not only by the maximum values of acceleration, but to a greater extent by its frequency spectrum and duration. Soil humidity in the dam core leads to redistribution of the stress-strain state of the dam.

Increase in soil humidity increasingly affects the stress-strain state of the dam. At the same time, the intensity of stresses in the core decreases, and in the areas of prisms directly adjacent to the core - increases. Thus, for example, at moisture content in the core W=10% $\sigma_{i\,\max}$ decreases to 8% in the core and increases to 30% in the prisms compared to the case of non-humidified core. At further increase of humidity, the intensity of stresses in the lower part of the core decreases by a factor of 1.5, and its increase in the upper part of the core reaches up to 15%.

## REFERENCES:

1. Зарецкий Ю.К., Ломбардо В.Н., Статика и динамика грунтовых плотин., Москва: Энергоиздат, 1983.
2. М.М.Мирсаидов, Е.И.Трояновский Динамика неоднородных систем с учетом внутренней диссипации и волнового уноса энергии. - Ташкент, Фан, 1990, 108с.
3. Mirsaidov, M., & Matkarimov, P. (2007). Dinamicheskaya zadacha dlya gruntovykh sooruzheniy, vzaimodeystvuyushchikh s zhidkostyu [Dynamic problem for soil structures interacting with a liquid]. *Doklady AN RUz*, (1), 25-28.
4. Маткаримов, П. Ж., & Мирсаидов, М. М. (1996). Исследование вынужденных колебаний неоднородной плоской системы с учетом пассивной виброизоляции. *Проблемы механики.*, (1-2), 23.

5. Маткаримов П., Жураев Д., Уразмухамедова З., «Определение собственных частот и форма колебаний плотин.,» *Журнал Проблемы механики № 1*, pp. с 25-33, 2022 г..

6. Matkarimov P.J., Juraev D.P., Usmonkhuzhaev S.I., «Studies of the dynamic behavior and stress-strain state of earth dams taking into account moisture,» *Journal of Microbiology Research Article Published online* , p. Vol. 15 №.1, April 2022.

7. Джураев Д. и Маткаримов П. (2023). Напряженно-деформированное состояние и прочность земляных плотин при статических нагрузках. В *сети конференций E3S* (том 365, стр. 03008). ЭДП наук.

8. Matkarimov P.J., Juraev D.P., Usmonkhuzhaev S.I. Stress-strain state of soil dams under the action of static loads. Scientific and Technical Jurnal NamIET, Vol. 8, Issue 2, 2023, pp. 221-228.

9. Холбоев З. и Усмонхужаев С. (2023). Влияние влажности грунта на напряженно-деформированное состояние земляной плотины. *Сеть синергии: Международный междисциплинарный исследовательский журнал* , *2* (6), 189–193.

10. К.С.Султанов, Б.Э.Хусанов Закономерности деформирования грунтов при просадке с учетом влажности. ДАН РУз, 2000, №9., с20-23

11. Рассказовский В.Т., Алиев И.А. Выборка нормированных акселерограмм землетрясений. - Ташкент, Фан, УзССР, 1991, 314 с.

12. Бате К., Вилсон Е. Численные методы анализа и метод конечных элементов. /Перевод с анг. -М.: Стройиздат, 1982. 448 с.

13. Калиткин Н.Н. Численные методы. -М.: Наука, 1988. 512 с.

14. Юлдашев С.С. и Маткаримов П.Дж. (2014). Распространение вибраций в грунтакс от транспортных средств и виброзащитные системы.

15. Ильичев В.А., Юлдашев С.С., Маткаримов П.З. Вынужденные колебания неоднородной планарной системы с пассивной виброизоляцией. *Soil Mech Found Eng* 36, 50–54 (1999).

16. Ильичев, В.А. (1999). Юлдашев Ш. С., Маткаримов П.Ж. *Механика грунтов и строительство фундаментов* , (2), 9-11.

17. Холбоев З. Х., Мавлонов Р. А. Исследование напряженно-деформированного состояния резаксайской плотины с учетом физически нелинейных свойств грунтов //Science Time. – 2017. – №. 3 (39). – С. 464-468.

18. Khodievich K. Z. Environmental Problems In The Development Of The Master Plan Of Settlements (In The Case Of The City Of Pop, Namangan Region Of The Republic Of Uzbekistan) //Global Scientific Review. – 2022. – T. 8. – C. 67-74.

19. Холбоев З. Х. КАНАДАДА ҚУРИЛИШНИ ТАРТИБГА СОЛИШ МЕЪЁР ВА ҚОИДАЛАРИ //PEDAGOG. – 2022. – Т. 1. – №. 4. – С. 683-692. 24.

20. Фозилов О. Қ., Холбоев З. Х. ҚУМ-ШАҒАЛ КАРЬЕРИ СИФАТИДА ДАРЁ ЎЗАНИДАН ФОЙДАЛАНИШДАГИ ЭКОЛОГИК МУАММОЛАР //PEDAGOG. – 2022. – Т. 1. – №. 3. – С. 229-238. 25.

21. Раззаков С. Ж., Холбоев З. Х., Косимов И. М. Определение динамических характеристик модели зданий, возведенных из малопрочных материалов. – 2020.

22. Холбоев З. Х. Аҳоли Пунктларини Бош Режасини Ишлаб Чиқишдаги Экологик Муаммолар //Gospodarka i Innowacje. – 2022. – Т. 28. – С. 142-149.

23. Razzakov S. J., Xolboev Z. X., Juraev E. S. Investigation of the Stress-Strain State of SingleStory Residential Buildings and an ExperimentalTheoretical Approach to Determining the Physicomechanical Characteristics of Wall Materials //Solid State Technology. – 2020. – Т. 63. – №. 4. – С. 523-540.

24. Холбоев З. ТАЛАБАЛАРДА КАСБИЙ КОМПЕТЕНЦИЯЛАРИНИ ШАКЛАНТИРИШ МУАММОЛАРИ //PEDAGOG. – 2022. – Т. 1. – №. 4. – С. 673-682